

At the Group for Cooperative Autonomous Systems, there is an opening for a Master's thesis on the following topic

# Ethical Dilemmas in Cooperative Autonomous Driving

or

## Ethische Dilemmas beim kooperativen autonomen Fahren

### Idea

We perform theoretical as well as simulation-based performance evaluation of ethical dilemmas in cooperative autonomous driving. Dependence of the automated driving functions on the unreliable radio communication during cooperative maneuvering might result in accidents of different severity (cause harm).

We focus on longitudinal driving scenarios, when one of the vehicles performs emergency braking and communicates warning messages to the followers. Let us consider a formation of four autonomous connected vehicles as a motivating example.

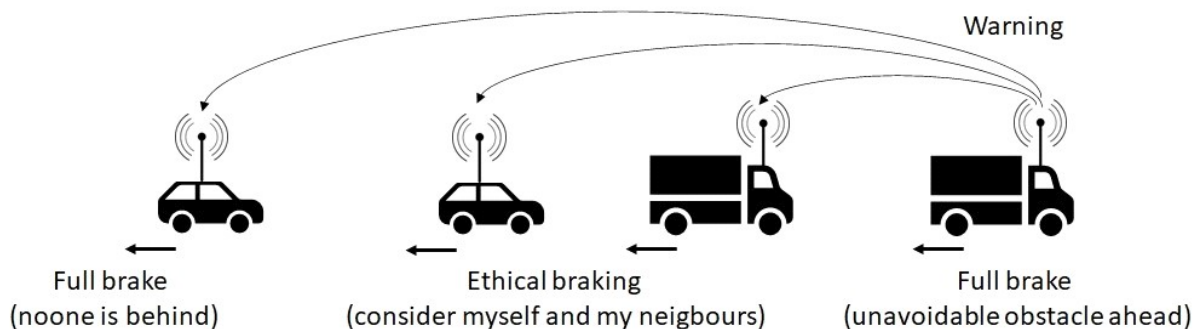


Figure 1: A motivating example.

The leader applies maximum emergency braking deceleration (due to an unavoidable obstacle ahead) and emits the periodic warning message, which is transmitted to the followers. On the reception of the message, the third follower applies maximum deceleration (since no one is behind). In contrast, the first and the second followers can decide on their braking strategies (e.g. brake smooth). The objective is to design braking strategies taking into account certain ethical considerations, for example:

- Objective 1 (“global”). Minimize the overall harm of the potential accident.
- Objective 2 (“save one”). Minimize the harm for one specific vehicle/user.
- Objective 3 (“fair”). Equalize harm among all the vehicles/users.

The following concrete research questions are suggested (the thesis can concentrate only on one/few of these or suggest other):

- What are the scenarios and the sets of input parameters resulting in ethical dilemmas?
- What are feasible braking strategies?
- Which information should be known a priori and/or be communicated between the vehicles to support these strategies?
- What is the impact of the communication unreliability?

## Approach

### Theoretical evaluation

The severity of the accident depends on the masses of the vehicles, their mutual velocities at the moment of crash as well as other parameters [1]. For the mathematical analysis the approaches from [2] can be used.

### Simulation-based evaluation

Respective simulations in a realistic setting can be performed in PTV Vissim<sup>1</sup>. We also believe that ethical dilemmas would benefit from a 3D visualization<sup>2</sup> for a wider outreach.

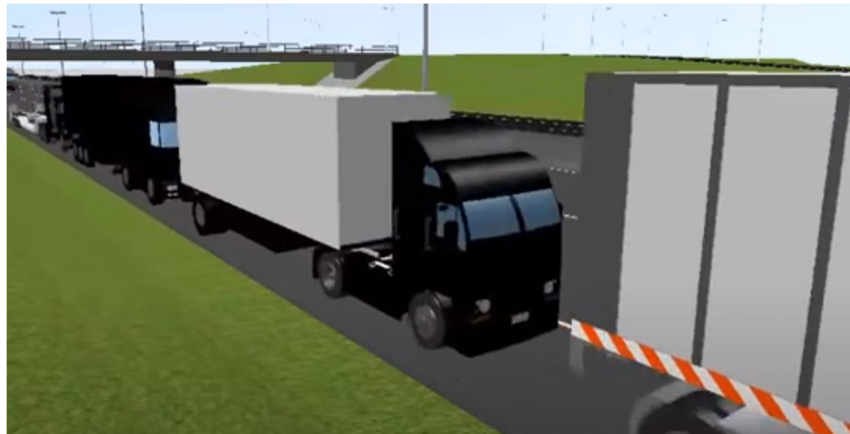


Figure 2: PTV simulations.

## Contact

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## References

- [1] Sidorenko, G., Thunberg, J., Sjöberg, K., Fedorov, A., & Vinel, A. (2021). Safety of automatic emergency braking in platooning. *IEEE Transactions on Vehicular Technology*, 71(3), 2319-2332.
- [2] Geisslinger, M., Poszler, F., & Lienkamp, M. (2023). An ethical trajectory planning algorithm for autonomous vehicles. *Nature Machine Intelligence*, 1-8.

<sup>1</sup> <https://h2020coexist.wpenginepowered.com/wp-content/uploads/2020/04/D2.11-Guide-for-the-simulation-of-AVs-with-microscopic-modelling-tool-Final.pdf>

<sup>2</sup> <https://youtu.be/Y3Fc3IjHLM>